

Claims

[c1] 1. Plate heat exchanger (1) device advantageously intended for use with a gas turbine, comprising a number of corrugated plates (2), each one with a first edge part (3) with an opposing second edge part (4), a third edge part (5) with an opposing fourth edge part (6), in which first and second flow channels (7, 8) are arranged between the corrugated plates (2), every first flow channel being arranged to have a through flow of a heat-emitting medium (9) and every second being arranged to have a through flow of a heat absorbing medium (10), the first flow channels for one of the mediums, advantageously the heat absorbing medium (10) are, via first inlet openings (11) and first outlet openings (12), respectively, connected essentially parallel to in-going and out-going junction channels (13, 14) for said heat absorbing medium (10), wherein that the plates (2) are fitted to each other in pairs, forming cells (15) comprising an inner spacing element (16) welded to and in-going between the plates, where the inner spacing element (16) extends along the edge parts (3-6) with interruption for the first inlet opening (11) and the first outlet opening (13) for one of the mediums, advantageously the heat-absorbing medium (10), where outer spacing elements (17) are welded to the plates (2) on the sides of the plates (2) facing away from each other, along at least two of the edge parts (3-6), the cells

(15) are stacked against each other and joined together by welding via the outer spacing elements (17), and said in-going and out-going junction channels (13, 14) are welded to said first inlet opening (11) and first outlet opening (12), respectively.

[c2] 2. Plate heat exchanger (1) device according to claim 1, wherein the first outlet opening (12) is wider than the first inlet opening (11).

[c3] 3. Plate heat exchanger (1) device according to claim 2, wherein the inner spacing element (16) of the cell (15) consists of a first inner spacing element (18) along the first edge part (3) and the fourth edge part (6) and a second inner spacing element (19) along the second edge part (4) and the third edge part (5), the first inner spacing element (18) has a first end section (20) thinner than the rest of the first spacing element (18), where the first end section (20) is pleated along the extension of the first inlet opening (11), and the second inner spacing element (19) has a second end section (21) thinner than the rest of the second spacing element (19), where the second end section (21) is pleated along the extension of the first outlet opening (12).

[c4] 4. Plate heat exchanger (1) device according to claim 3, wherein each of the pleated end sections (20, 21) of the first and second inner spacing elements (18, 19), has a first and a

second pleating height, respectively (22, 23), which allows the pleated end sections (20, 21) to act as spacing elements in the first inlet opening (11) and the first outlet opening (12), respectively.

[c5] 5. Plate heat exchanger (1) device according to claim 4, wherein the corrugated plates (2) are divided into first plates (24) with a first side (25) and a second side (26), corrugated with a first pattern (27), and second plates (28) with a third side (29) and a fourth side (30) corrugated with a second pattern (31), which first and second plates (24, 28) are assembled in pairs with the second side (26) towards the third side (29).

[c6] 6. Plate heat exchanger (1) device according to claim 5, wherein the first plates (24) are corrugated in such a way that each of the first plates has first depressions (32) and first ridges (33) on the first side, and correspondingly second depressions (34) and second ridges (35) on the second side (26), diagonally from the third edge part (5) to the fourth edge part (6), with the first and the fourth edge parts (3, 6) constituting catheti in an imaginary triangle with the diagonal first depressions (32) as hypotenuse, and in that each of the second plates (28) has third depressions (36) and third ridges (37) on the third side (29), and correspondingly fourth depressions (38) and fourth ridges (39) on the fourth side (30),

diagonally from the fourth edge part (6) to the third edge part (5), with the first and third edge parts (3, 5) constituting catheti in an imaginary triangle with the diagonal third depressions (36) as hypotenuse.

[c7] 7. Plate heat exchanger (1) device according to claim 6, wherein the depth of the first and fourth depressions (32, 38), respectively, varies in such a way that a first inlet triangle (40) and a first outlet triangle (41) with a first depth (49) on the first depressions (32) are formed in the first plate (24), and a second inlet triangle (42) and a second outlet triangle (43) with a second depth of the fourth depressions (38) are formed in the second plate (28), which first and second inlet triangles (40, 42) have a feature in the shape of a triangle at the respective plates (24, 28), with an imaginary cathetus along the first edge part (3) with a length corresponding to the first inlet opening (11), an imaginary cathetus in the third end part (5) and an imaginary hypotenuse from the first edge part (3) to the second edge part (4), where each of the first and second outlet triangles (41, 43) has the shape of an imaginary cathetus along the second edge part (4) with a length corresponding to the first outlet opening (12), an imaginary cathetus in the fourth edge part (6) and an imaginary hypotenuse from the second edge part (4) to the first edge part (3), and the first plate also has a first diagonal

section (44) with a third depth (50) of the first depressions (32), the second plate (28) has a second diagonal section (45) with a fourth depth of the fourth depressions (38, which diagonal sections (44, 45) are formed diagonally over each of the plates (24, 28) between the inlet triangles and outlet triangles respectively.

[c8] 8. Plate heat exchanger (1) device according to claim 7, wherein each of the first and second plates, the first inlet triangle (40) and the second inlet triangle (42) have the same geometrical shape, and the first diagonal section (44) and the second diagonal section (45) have the same geometrical shape, and the first outlet triangle (41) and the second outlet triangle (43) have the same geometrical shape.

[c9] 9. Plate heat exchanger (1) device according to claim 8, wherein the cells (15) consist of the first and second plates (24, 28) joined in pairs with the second and third sides (26, 29) placed towards each other, wherein the second ridges (35) form an angle with the third ridges (37), and in that the first and second inlet triangles (40, 42) form a first cross-stream section (46), the first and second outlet triangles (41, 43) form a second cross-stream section (47), and in that the first and second diagonal sections (44, 45) form a counter-stream section (48).

[c10] 10. Plate heat exchanger (1) device according to claim 9,

wherein the second ridges (35) are in contact with the third ridges (37) in the first points of intersection at that part of the cell (15) that is formed by the diagonal sections (44, 45) of the plates (24, 28).

[c11] 11. Plate heat exchanger (1) device according to claim 10, wherein the cells (15) are stacked against each other with the first and fourth sides (25, 30) of the plates (24, 28) towards each other.

[c12] 12. Plate heat exchanger (1) device according to claim 11, wherein the first ridges (33) form an angle to the fourth ridges (39) when the cells (15) are stacked, and additionally the first ridges (33) are in contact with the fourth ridges (39) in the second points of intersection.

[c13] 13. Plate heat exchanger (1) device according to claim 12, wherein the thickness of said outer spacing element (17) is such that the upper edge of the outer spacing elements (17) is in alignment with the first ridges (33) on the first side (25) and is in alignment with the fourth ridges (39) on the fourth side (30)

[c14] 14. Plate heat exchanger (1) device according to claim 13, wherein the thickness of said outer spacing element (17) is essentially twice the thickness of the inner spacing element.

[c15] 15. Plate heat exchanger (1) device according to claim 14, wherein additional in-going and out-going junction channels (55, 56) are welded to the recuperator, parallel to the in-going and out-going junction channels (13, 14), on the opposite side of the recuperator sides formed by the cells (15), where the in-going and out-going junction channels (13, 14) are welded to the sides.

[c16] 16. Plate heat exchanger (1) device according to claim 15, wherein the additional inlet and outlet openings (57, 58) are arranged in the cell (15) on that distance that is formed by the width of the respective longitudinal openings of the in-going and out-going junction channels (55, 56).

[c17] 17. Plate heat exchanger (1) device according to claim 1, wherein the welding refers to laser welding.

[c18] 18. Method for manufacturing a heat exchanger (1) device advantageously intended for use with a gas turbine, wherein a number of corrugated plates (2), each one with a first edge part (3) with an opposing second edge part (4), a third edge part (5) with an opposing fourth edge part (6), are arranged in such a way that first and second flow channels (7, 8) are arranged between the corrugated plates (2), where every first flow channel is arranged to have a through flow of a heat-emitting medium (9) and every second is arranged to have a through flow of a heat absorbing medium (10), wherein the

first flow channels (7) for one of the mediums, advantageously the heat absorbing medium (10), are brought to parallel communication with in-going and out-going junction channels

(13, 14) respectively, via first inlet openings (11) and first outlet openings (12), for said one of the mediums, wherein cells (15) are formed by;

- an inner spacing element (16) being welded between two plates (2), where the inner spacing element (16) extends along the edge parts (3-6) of the plates with interruptions for the first inlet openings (11) and the first outlet openings (12);

- an outer spacing element (17) being welded to at least the two remaining sides of the plates which are facing away from each other, along at least two of the edge parts (3-6);

- the two previous steps are repeated until a predetermined number of cells (15) have been produced for one of the mediums, preferably the heat absorbing medium (10);

- the cells (15) are successively stacked against each other in such a way that the outer spacing elements (17) on mutually adjacent cells are in direct contact with each other;

- the outer spacing elements (17) are welded together in such a way that the cells form a coherent package where the distance between the cells forms second flow channels (8) for the second medium (9); and

- said in-going and out-going junction channels (13, 14) are welded to said first inlet openings (22) and first outlet openings

(12) respectively.

[c19] 19. Method for manufacturing a plate heat exchanger (1) device according to claim 18, wherein two gas tight end covers are welded to short ends of the in-going and out-going junction channels (13, 14), where each of the end covers are welded also to the plates (2) that are placed on the short sides of the recuperator.

[c20] 20. Method for manufacturing a plate heat exchanger (1) device according to claim 19, wherein the inner spacing element (16) of the cell (12) consists of a first inner spacing element (18) along the first edge part (3) and the fourth edge part (6), with a first end section (20) thinner than the rest of the first spacing element (18), which first end section (20) is pleated along the extension of the first inlet opening (11); and a second inner spacing element (19) is arranged along the second edge part (4) and the third edge part (5), with a second end section (21) thinner than the rest of the second spacing element (19), which second end section (21) is pleated along the extension of the first outlet opening (12).

[c21] 21. Method for manufacturing a plate heat exchanger (1) device according to claim 20, wherein the welding is done by laser welding.

[c22] 22. Method for manufacturing a plate heat exchanger (1)

device according to claim 21, wherein the corrugated plates are made mainly rectangular and that each one is cut and pressed at the same time, where the plates are divided into first plates (24) with a first side (25) and a second side (26), which first plates (24) are corrugated with a first pattern (27), and second plates (28) with a third side (29) and fourth side (30), which second plates (28) are corrugated with a second pattern (31), wherein cells are formed by assembling the first and second plates (24, 28) in pairs with the second side (26) towards the third side (29),.

[c23] 23. Method for manufacturing a plate heat exchanger (1) device according to claim 22, wherein the cells (15) are stacked against each other with the first and fourth sides (25, 30) of the plates (24, 28) towards each other.

[c24] 24. Method for manufacturing a plate heat exchanger (1) device according to claim 23, wherein the first outlet opening (12) of the cell is made wider than the first inlet opening (11) of the cell.